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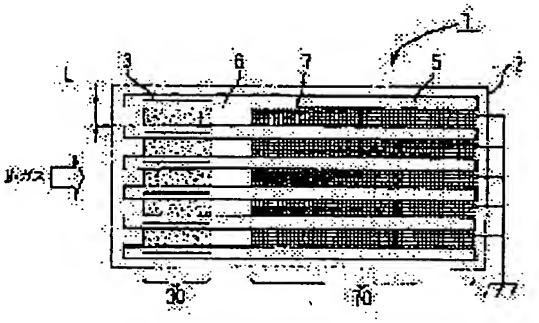
(54) EXHAUST EMISSION CONTROL DEVICE FOR INTERNAL COMBUSTION ENGINE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an exhaust emission control device for an internal combustion engine formed that the discharge part and the duct collection part 7 of the exhaust emission control device are separately situated to stabilize discharge at the discharge part and the control efficiency of exhaust gas can be improved.
SOLUTION: The discharge part 30 and a dust collection part 70 are situated separately into the upper stream side and the downstream side of a flow passage 6, a distance between electrodes 3 can be arbitrarily set to stabilize discharge. The dust collection part 70 consists of a conductive material 7 having a plurality of gap-form spaces through which exhaust gas passes and is fixed at an earth electric potential. By electrifying PM by the discharge part 30, PM is attracted to the surface of the conductive material 7 for trapping. In purification of a gaseous pollutant (NOx), in the discharge part 30 and the dust collection part 70 carrying a catalyst, radical and active gas generated from the discharge part 30 are brought into contact with exhaust gas for purification.



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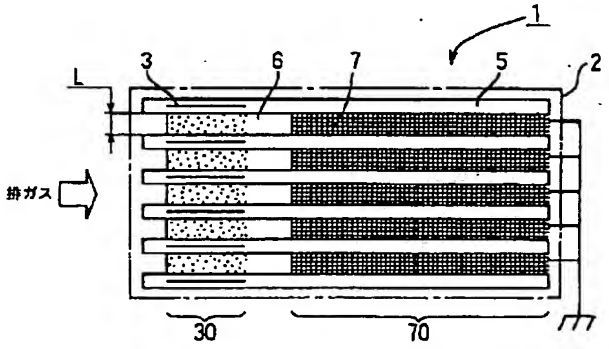
最終頁に続く

(54)【発明の名称】　内燃機関の排気浄化装置

(57)【要約】
【課題】　排気浄化装置の放電部と集塵部７とを分けて配置して、放電部での放電を安定させるとともに、排ガスの浄化効率を高めることが可能な内燃機関の排気浄化装置を提供する。
【解決手段】　放電部３０と集塵部７０とを、排ガスが流れる流路６の上流側と下流側に分けて配置させて、電極３間の距離を任意設定可能とし放電を安定させる。そして、集塵部７０を排ガスが通過する複数の隙間状の空間を有する導電体７で構成し、アース電位に固定する。放電部３０にてＰＭに帯電させることで、ＰＭを導電体７の表面に吸着させて捕捉する。ガス状汚染物質（ＮＯｘ等）の浄化では、放電部３０および触媒を担持した集塵部７０において、放電部３０より発生するラジカルや活性ガス等と排ガスとを接触させて浄化する。



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【特許請求の範囲】

【請求項１】　内燃機関の排ガスが流れる流路の上流側に配置され、プラズマを発生させる放電部と、

前記放電部の下流側の前記流路に配置され、かつ少なくとも一部が導電体で構成される集塵部とを備え、

前記導電体は、所定電位に固定されて前記排ガス中の粒子状汚染物質を捕捉することを特徴とする内燃機関の排気浄化装置。

【請求項２】　前記集塵部は、平面状に構成され、排ガスの流れと平行に配置されたことを特徴とする請求項１に記載の内燃機関の排気浄化装置。

【請求項３】　前記集塵部は、触媒が担持されることを特徴とする請求項１ないし請求項２のいずれか１項に記載の内燃機関の排気浄化装置。

【請求項４】　内燃機関の排ガスが流れる流路を挟んで対向配置した第１、第２絶縁基板と、前記第１、第２絶縁基板内にそれぞれ配設した第１、第２電極とからなる放電部を備え、

前記放電部によって前記流路内にプラズマを発生させることで、排ガスを浄化する内燃機関の排気浄化装置において、

前記放電部の下流側の前記流路に配置され、かつ少なくとも一部が導電体で構成されるとともに複数の隙間状の空間を有する構造の集塵部を備え、

前記導電体は、前記第１、第２絶縁基板で鋏まれるとともに所定電位に固定されて、前記排ガス中の粒子状汚染物質を捕捉することを特徴とする内燃機関の排気浄化装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、放電を利用して排ガスの浄化反応を促進させる排気浄化装置に関し、特にディーゼルエンジン等の排ガス中に含まれる粒子状汚染物質およびガス状汚染物質を分解・除去する排気浄化装置に関する。

【０００２】

【従来の技術】ディーゼルエンジン等の排ガス中には、カーボンを主成分とする粒子状汚染物質（ＰＭ：Ｐａｒｔｉｃｕｌａｔｅ　Ｍａｔｔｅｒ）、ならびに窒素酸化物（以降、ＮＯｘと呼ぶ）等のガス状汚染物質からなる有害物質が含まれている。この排ガス中の有害物質（ＰＭ、ＮＯｘ等）を排出源において除去する内燃機関の排気浄化技術が研究されている。この技術は、例えば特開平９－３２９０１５号公報（図１１参照）に示すように、交流高圧電源１００と接続された一対の電極１０１、１０２間に誘導体で構成された集塵部（多孔質フィルタ層）１０３を配置させている。また、各電極１０１、１０２と集塵部１０３との間に放電空間１０４、１０５を各々設けている。

【０００３】そして、一方の放電空間１０４に処理対象ガス１０６を流し、集塵部１０３を通過させたのち他方の放電空間１０５を経て処理終了ガス１０７を排出させている。この集塵部１０３を処理対象ガス１０６が通過する際、集塵部１０３内部でＰＭが捕捉されたのち放電により発生するプラズマと反応して二酸化炭素に変換され集塵部１０３から除去される。また、ＮＯｘ等のガス状汚染物質は、集塵部１０３を通過しながら放電により発生するプラズマとの衝突確率を高めて浄化される。

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【０００４】

【発明が解決しようとする課題】しかし、特開平９－３２９０１５号公報に開示されている排気浄化装置は、一対の電極１０１、１０２間に集塵部１０３と、放電空間１０４、１０５を設ける構成であるので、電極１０１、１０２間の距離が大きくなる。この電極１０１、１０２間の距離を大きくすると、要求印加電圧（放電を発生させることができる電圧）が高くなり、放電が困難になる問題がある。更に、集塵部１０３は、誘導体である多孔質フィルタ層にて構成され、集塵部１０３内部の細孔にＰＭを引っかけるように捕捉しているのであって、この細孔に引っかからないような微粒子のＰＭは、捕捉できない問題がある。

【０００５】本発明の目的は上記の点に鑑み、放電を安定させるとともに、集塵部での排ガスの浄化効率を高めることが可能な内燃機関の排気浄化装置を提供することにある。

【０００６】

【課題を解決するための手段】上述した課題を解決するために、本発明の請求項１記載の内燃機関の排気浄化装置によると、放電部と集塵部とを、排ガスが流れる流路の上流側と下流側に分けて配置する構成とした。この排気浄化装置の構成において、上流側に配置した放電部からのプラズマと排ガス中のＰＭ、ＮＯｘ等のガス状汚染物質とが衝突するとともに、下流側に配置した集塵部を通過しながら更にプラズマによって発生するラジカルや活性ガス等との衝突確率を高めて浄化される。特に、粒子状汚染物質（ＰＭ）は、集塵部の導電体が所定電位に固定されていることから、放電部でプラズマと反応して帯電されたＰＭが導電体に吸着する。これにより、微小な粒子状汚染物質（ＰＭ）であっても捕捉されたのち、放電部で発生するプラズマと反応して二酸化炭素に変換され集塵部から除去される。

【０００７】また、従来のように放電部の電極間に集塵部を鋏む構成ではないので、電極間の距離が大きくなる事はない。つまり、集塵部が配置されることによる放電部への影響がなく放電部での放電が安定する内燃機関の排気浄化装置を提供できる。

【０００８】本発明の請求項２によると、排ガスが集塵部に設けられた複数の隙間状の空間を通過することで、粒子状汚染物質（ＰＭ）は集塵部の表面に吸着させて捕捉する。そして、この捕捉した粒子状汚染物質（ＰＭ）

と放電部よりのプラズマとを反応させ二酸化炭素に変換したのち集塵部から除去する。

【０００９】本発明の請求項２によると、集塵部を平面状に構成し排ガスの流れと平行に配置することで、排ガスが集塵部を通過する際の圧損抵抗を低減させる効果がある。

【００１０】本発明の請求項３によると、集塵部を触媒で担持することで、集塵部において窒素酸化物（以降、ＮＯｘと呼ぶ）等のガス状汚染物質を浄化させる効果がある。

【００１１】本発明の請求項４によると、請求項１および請求項３記載の効果に加え、排ガスが流れる流路を挟んで対向配置した第１、第２絶縁基板の上流側に放電部、下流側に集塵部を備える構成とした。つまり、集塵部の一部を構成する導電体が対向する第１、第２絶縁基板間に保持されるとともに、第１、第２絶縁基板間の流路は、上流側の放電部よりのプラズマによって発生するラジカルや活性ガス等を集塵部の導電体側に導く構成の排気浄化装置とした。このように、第１、第２絶縁基板により排ガス通路を構成するとともに、集塵部を挟んで保持する機能を持たせたので排気浄化装置自体をコンパクトに構成できる。

【００１２】

【発明の実施の形態】以下、本発明の一実施形態である内燃機関の排気浄化装置を、図面を参照して詳細に説明する。なお、図１に示すように、排気浄化装置１は、後述する放電部３０と集塵部７０を含むプラズマ発生装置２と、このプラズマ発生装置２内の放電部３０の電極３に高周波の交流高電圧を印加する高圧電源発生部４とにより構成される。そして、図７に示すように、プラズマ発生装置２を内燃機関であるエンジン５０の排気管５１の途中に配置している。

【００１３】次に、プラズマ発生装置２の構成を図１から図３を用いて説明する。図１は、本発明の一実施形態のプラズマ発生装置２の概略構成図である。図２は、図１中の絶縁基板５を示す詳細図で、（ａ）は平面図（ｂ）は側面図である。図３は、図１に示したプラズマ発生装置のＡ－Ａ線断面に沿った概略構成図である。

【００１４】プラズマ発生装置２は、放電部３０と集塵部７０からなる。この装置２内には、複数の絶縁基板５が所定間隔で平行に配置され、各絶縁基板５間に排ガスが通過する偏平な流路６が形成されている。各絶縁基板５は、放電の生じやすい誘電性のある耐熱性絶縁体（例えばアルミナ等のセラミック、又はガラス等）で形成されている。各絶縁基板５内には、それぞれ印刷導体又は導電板によって形成された放電用の電極３が埋め込まれている。

【００１５】これら放電用の電極３は、排ガスが流れる流路６の上流側に配置される。つまり、流路６を挟んで対向した各絶縁基板５内の複数の電極３は、排ガスが流れる流路６の上流側の各絶縁基板５内にのみに埋め込まれる。そして、これら複数の電極３と高圧電源発生部４とを接続端子３ａを介して接続して、高周波の交流高電圧を印加しプラズマを発生させる放電部３０を構成している。

【００１６】また、集塵部７０は、放電部３０の下流側に配置されている。つまり、上記した放電部３０と集塵部７０とを、排ガスが流れる流路６の上流側と下流側に分けて配置する構成とした。この集塵部７０を主要構成する導電体７は、放電部３０より延長された各絶縁基板５で挟まれるとともに、所定電位としてアース電位（接地）に固定されている。そして、導電体７は、図４に正面流路構造を示すように、排ガスが通過する複数の隙間状の空間を有する構造であり、本例ではステンレス鋼を用いて正面が網目状で、かつ外形が立方体構造に形成されている。

【００１７】このように、上述した構成の集塵部７０は、放電部３０の電極３間に集塵部７０を挟む構成ではないので、電極３間の距離Ｌ（図３中に図示）が大きくなる事はない。つまり、電極３間の距離が大きくなると、要求印加電圧（放電を発生させることができる電圧）が高くなり放電が困難になるが、集塵部７０が分けて配置されるため、電極３間の距離を任意に設定可能となる。従って、放電部での放電が安定する電極間距離が設定でき、放電の安定したプラズマ発生装置２を構成できる。

【００１８】また、集塵部７０は、排ガスが通過する複数の隙間状の空間を有するとともに、導電体７がアース電位に固定されているので、放電により帯電される粒子状汚染物質（ＰＭ）を導電体７の表面に吸着させて捕捉を促進する。

【００１９】ＰＭが、集塵部７０の導電体７の表面に吸着される過程を図５に示す。図５は、図１、３に示したプラズマ発生装置２の集塵部７０の集塵動作の原理を示す説明図である。図５に示すように、ＰＭは放電部３０を通過する際にプラズマと反応して帯電することで、プラスまたはマイナスの電位レベル状態となる。そして、アース電位に固定されることで電位レベルがゼロ状態の導電体７に対し、プラスまたはマイナスの電位レベルに変化したＰＭが吸着するのである。そして、導電体７にて捕捉したＰＭは、導電体７に留まりながら放電部３０よりの発生するラジカルや活性ガス等と反応させ、二酸化炭素に変換したのち導電体７から除去される。なお、ＰＭが二酸化炭素に変換される反応の詳細は、後述する。

【００２０】このように、放電部３０に高周波の交流高電圧を印加してＰＭ帯電させることで、微粒子のＰＭであっても集塵部７０にて捕捉できる。その捕捉効果は、図６に示すように、放電部３０に通電しない場合（図６中（イ）の破線）と比較して、放電部３０に通電するこ

とで図６中（ロ）の実線に示すように、微粒子のＰＭから大粒のＰＭまでを捕捉することができる。

【００２１】上述した構成のプラズマ発生装置２は、集塵部７０において、排ガス流路６を鉄んで対向配置された絶縁基板５間の距離を規定間隔に保持し、かつ流路６を通して上流側の放電部３０より発生するラジカルや活性ガス等を導電体７へ導くことができる。このように、対向させた絶縁基板５により排ガス通路を構成するとともに、集塵部７０を鉄んで保持する機能を持たせたので排気浄化装置１自体をコンパクトに構成できる。

【００２２】以上のように構成した排気浄化装置１の作用について、以下説明する。エンジン５０が始動されて、ＮＯｘ等のガス状汚染物質、および粒子状汚染物質（ＰＭ）等の有害成分を含んだ排ガスが排気管５１を介してプラズマ発生装置２に導かれる状態において、放電部３０では、高圧電源発生装置４から各流路６を挟んで対向する複数の電極３に高周波の高圧交流電圧が印加される。

【００２３】この高周波の高圧交流電圧が電極３に印加され、電極３間に放電が発生することにより、排ガス中の酸素分子と放電による加速電子ｅとが反応し、Ｏラジカル（Ｏ＊）が生成される。そして、このＯラジカル（Ｏ＊）と排ガス中の一酸化窒素（ＮＯ）とが結合し、二酸化窒素（NO_2）が生成される。

【００２４】ここで、有害成分である排ガス中の粒子状汚染物質（ＰＭ）の浄化は、炭素（Ｃ）を主成分とする煤（ＳＯＯＴ）、および炭化水素（ＨＣ）を主成分とする未燃焼体（Ｓ．Ｏ．Ｆ．）に大別される。この炭素（Ｃ）、および炭化水素（ＨＣ）と、放電により生成される二酸化窒素（NO_2）とは、次式に示すように反応する。煤（ＳＯＯＴ）の場合は、$C+NO_2 \rightarrow CO_2 + NO$となり、未燃焼体（Ｓ．Ｏ．Ｆ．）の場合は、$HC+NO_2 \rightarrow CO_2 + H2O + NO$のように反応する。なお、粒子状汚染物質（ＰＭ）と放電により生成される二酸化窒素（NO_2）とは、低温環境下でも反応する。

【００２５】次に、有害成分である排気ガス中のガス状汚染物の窒素酸化物（ＮＯｘ）の浄化においては、ガス状汚染物（ＮＯｘ）と放電により生成されるＯラジカル（Ｏ＊）とが、放電部３０および触媒を担持した集塵部７０の双方を通過しながら次式に示すように還元反応し、無害なガス（CO_2、N_2）、および水となって排出される。

【００２６】窒素酸化物（ＮＯｘ）は、二酸化窒素（NO_2）と一酸化窒素（ＮＯ）の複合化合物であり、放電により一酸化窒素（ＮＯ）を二酸化窒素（NO_2）に酸化させて排ガスの浄化を促進させている。また、還元剤である炭化水素（ＨＣ）は、未燃焼成分として排ガス中に含まれている。そこで、二酸化窒素（NO_2）の場合は、$NO_2 + HC \rightarrow N_2 + CO_2 + H_2O$となり、浄化される。

【００２７】このように、排気浄化装置１の放電部３０と触媒を担持した集塵部７０とを排ガス流路の流れる方向に分けて配置する構成としたことにより、放電部３０での放電を安定させるとともに、放電部３０で発生したプラズマと排ガス成分との衝突（接触）確率を高め、ＰＭ、ＮＯｘの浄化効率を高めることが可能な内燃機関の排気浄化装置１を提供できる。

【００２８】（変形例）本発明の変形例であるプラズマ発生装置２Ａを図８に示す。図８は、本発明の変形例であるプラズマ発生装置の断面を示す概略構成図である。図１から図３に示す一実施形態のプラズマ発生装置２と実質的に同一構成部品に同一符号を付し、説明を省略する。図８に示すプラズマ発生装置２Ａは、図１から図３に示したプラズマ発生装置２に対し、集塵部７０の導電体１７を平面板状に延びる導電板または導電層にて構成するとともに、この導電体１７を排ガスの流れと平行に配置した点が異なる。

【００２９】この導電体１７の構成により、排ガスが集塵部７０を通過する際の圧損抵抗を低減させる効果がある。

【００３０】なお、本発明の実施にあたり、放電部３０を内装する絶縁基板５を延長させ、放電部７０の導電体７、１７をこの延長された絶縁基板５で鉄んで構成したが、放電部３０と集塵部７０とを、排ガスが流れる流路６の上流側と下流側に分けて配置し、集塵部７０が配置されることによる放電部３０への影響を無くせばよいのであって、放電部３０を内装する絶縁基板５と集塵部導電体７、１７とを別体で配置構成してもよい。また、この別体構成時の導電体７、１７は、複数層に構成してもよいし、一体化されて単体で構成してもよい。

【００３１】また、本発明の実施にあたり、網目状に立方体構成させたステンレス鋼製の導電体７の網目表面に、触媒を担持させてもよい。この担持する触媒は、ＮＯｘを排ガス中のＨＣ、ＣＯ、H_2などの還元性成分によってＮ２とＯ２に分離する選択還元触媒、ＨＣ、ＣＯ、ＮＯｘの３つの有害成分を同時に処理する３元触媒、および酸化触媒のいずれの触媒を選択するか、あるいは複数の触媒を組合わせて使用される。このように、集塵部７０に触媒を担持させることで、ガス状汚染物の窒素酸化物（ＮＯｘ等）の浄化作用を助長させる効果がある。

【００３２】また更に、本発明の実施にあたり、ステンレス鋼製の導電体７に代えて、図９に示す導電体７Ａを用いてもよい。この導電体７Ａは、多孔質体（例えばアルミナ等のセラミック、又はガラス等で構成）よりなり、この多孔質体表面に金属メッキすることで、導電性をもった導電体を構成している。

【００３３】また更に、本発明の実施にあたり、図１０に示すように、プラズマ発生装置２と触媒装置５２とを組合わせて配置した排気浄化装置２の構成としてもよ

い。この触媒装置５２はプラズマ発生装置２の排ガス下流に配置されており、プラズマ発生装置２を通過するガス状汚染物がある場合でも、触媒装置５２がこの通過したガス状汚染物を浄化することができる。

【図面の簡単な説明】

【図１】本発明の一実施形態のプラズマ発生装置の概略構成図である。

【図２】図１中の絶縁基板を示し、（ａ）は平面図で、（ｂ）は図２（ａ）の側面図である。

【図３】図１に示したプラズマ発生装置のＡ－Ａ線断面に沿った概略構成図である。

【図４】図１中の集塵部を示す正面図である。

【図５】図１に示したプラズマ発生装置の集塵動作の原理を示す説明図である。

【図６】ＰＭ粒径とＰＭ捕捉量との関係を示す特性図である。

【図７】本発明の一実施形態の排気浄化装置全体を示す＊概略構成図である。

【図８】本発明の変形例であるプラズマ発生装置の概略構成図である。

【図９】集塵部の変形例を示す正面図である。

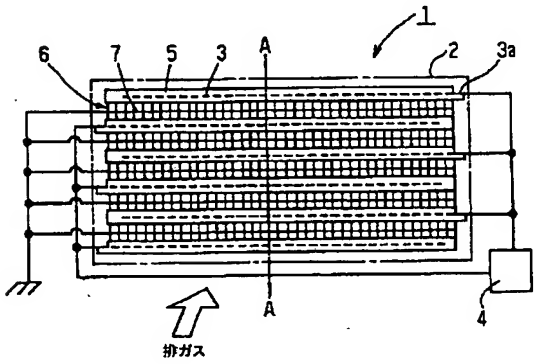
【図１０】排気浄化装置全体の変形例を示す概略構成図である。

【図１１】従来のプラズマ発生装置の概略構成図である。

【符号の説明】

１　排気浄化装置
２　プラズマ発生装置
３　電極
５　絶縁基板
６　流路
７　導電体
３０　放電部
７０　集塵部

【図１】



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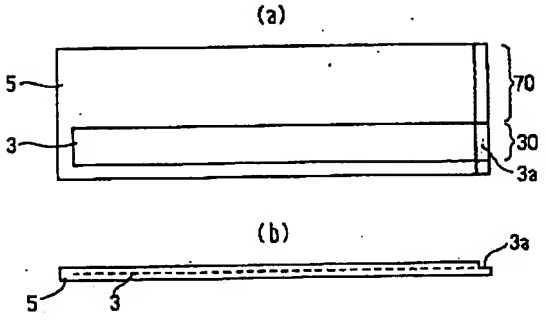

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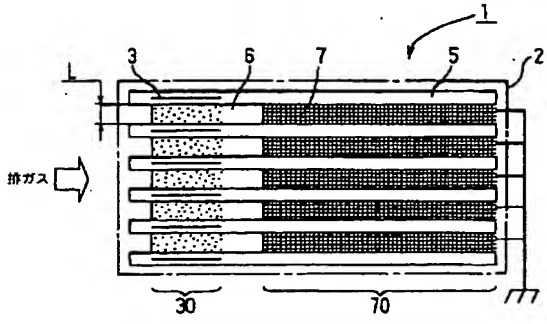

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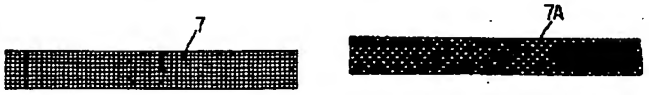

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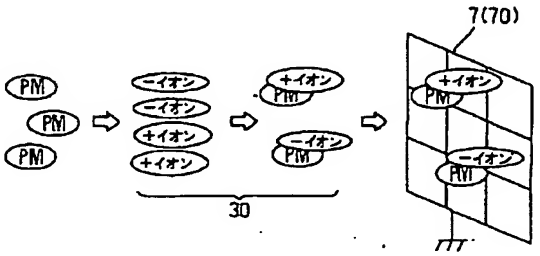
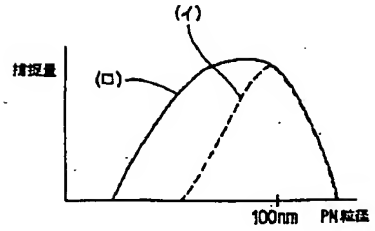


【図９】

【図６】



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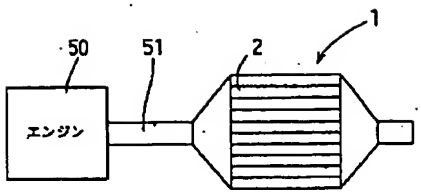

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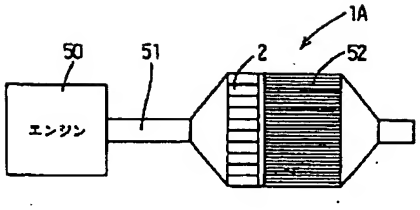

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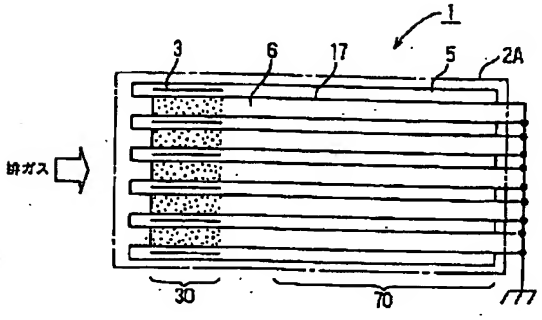
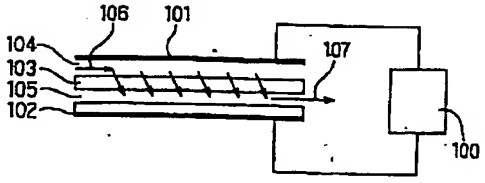


【図１１】



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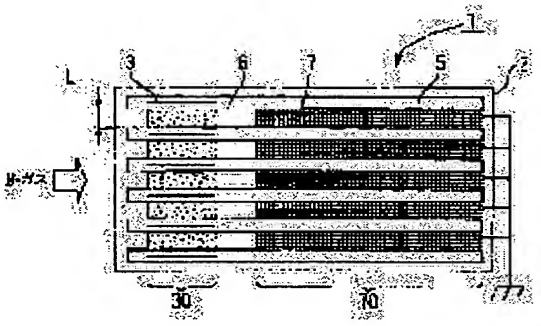
(54) EXHAUST EMISSION CONTROL DEVICE FOR INTERNAL COMBUSTION ENGINE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an exhaust emission control device for an internal combustion engine formed that the discharge part and the duct collection part 7 of the exhaust emission control device are separately situated to stabilize discharge at the discharge part and the control efficiency of exhaust gas can be improved.

SOLUTION: The discharge part 30 and a dust collection part 70 are situated separately into the upper stream side and the downstream side of a flow passage 6, a distance between electrodes 3 can be arbitrarily set to stabilize discharge. The dust collection part 70 consists of a conductive material 7 having a plurality of gap-form spaces through which exhaust gas passes and is fixed at an earth electric potential. By electrifying PM by the discharge part 30, PM is attracted to the surface of the conductive material 7 for trapping. In purification of a gaseous pollutant (NOx), in the discharge part 30 and the dust collection part 70 carrying a catalyst, radical and active gas generated from the discharge part 30 are brought into contact with exhaust gas for purification.



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CLAIMS

[Claim(s)]
[Claim 1] It is the exhaust emission control device of the internal combustion engine characterized by having the dust collection section by which it is arranged at the upstream of the passage where an internal combustion engine's exhaust gas flows, and is arranged in said passage of the downstream of the discharge section which generates the plasma, and said discharge section, and at least a part is constituted from a conductor, fixing said conductor to predetermined potential, and catching the particulate matter in said exhaust gas.
[Claim 2] Said dust collection section is the exhaust emission control device of the internal combustion engine according to claim 1 characterized by having been constituted by the plane and having been arranged at the flow of exhaust gas, and parallel.
[Claim 3] Said dust collection section is the exhaust emission control device of an internal combustion engine given in any 1 term of claim 1 characterized by supporting a catalyst thru/or claim 2.
[Claim 4] The 1st and 2nd insulating substrate which carried out opposite arrangement across the passage where an internal combustion engine's exhaust gas flows, By having the discharge section which consists of the 1st and 2nd electrode arranged in said 1st and 2nd insulating substrate, respectively, and generating the plasma in said passage by said discharge section In the exhaust emission control device of the internal combustion engine which purifies exhaust gas, it is arranged in said passage of the downstream of said discharge section. It has the dust collection section of structure which has the space of the shape of two or more clearance while at least a part consists of conductors. And said conductor The exhaust emission control device of the internal combustion engine characterized by being fixed to predetermined potential with scissors rare ** by said 1st and 2nd insulating substrate, and catching the particulate matter in said exhaust gas.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the exhaust emission control device from which the particulate matter and the gaseous pollutant which are especially contained in exhaust gas, such as a diesel power plant, are disassembled and removed about the exhaust emission control device which promotes the purification reaction of exhaust gas using discharge.
[0002]
[Description of the Prior Art] In exhaust gas, such as a diesel power plant, the harmful matter which consists of gaseous pollutants, such as particulate matter (PM:Particulate Matter) which uses carbon as a principal component, and nitrogen oxides (henceforth referred to as NOx), is contained. The exhaust air purification technique of the internal combustion engine which removes the harmful matter in this exhaust gas (PM, NOx, etc.) in the source of discharge is studied. This technique is arranging the electrode 101 of a pair connected with the alternating current high voltage power supply 100, and the dust collection section (porosity filter layer) 103 which consisted of derivatives among 102, as shown in JP,9-329015,A (refer to drawing 11). Moreover, discharge space 104 and 105 is respectively formed between each electrodes 101 and 102 and the dust collection section 103.
[0003] And after making one discharge space 104 pass a sink and the dust collection section 103 for processing-object gas 106, processing termination gas 107 is made to discharge through the discharge space 105 of another side. In case processing-object gas 106 passes this dust collection section 103, after PM is caught in the dust collection section 103 interior, it reacts with the plasma generated by discharge, is changed into a carbon dioxide, and is removed from the dust collection section 103. Moreover, passing the dust collection section 103, gaseous pollutants, such as NOx, raise a probability of collision with the plasma generated by discharge, and are purified.
[0004]
[Problem(s) to be Solved by the Invention] However, since the exhaust emission control device currently indicated by JP,9-329015,A is the configuration of forming the dust collection section 103 and discharge space 104 and 105 between the electrode 101 of a pair, and 102, the distance between an electrode 101 and 102 becomes large. When distance between this electrode 101 and 102 is enlarged, there is a problem to which demand applied voltage (electrical potential difference which can generate discharge) becomes high, and discharge becomes difficult. Furthermore, the dust collection section 103 consisted of porosity filter layers which are derivatives, it is caught so that PM may be hooked on the pore of the dust collection section 103 interior, and PM of a particle which is not caught in this pore has the problem which cannot be caught.
[0005] The purpose of this invention is to offer the exhaust emission control device of the internal combustion engine which can raise the purification effectiveness of the exhaust gas in the dust collection section while stabilizing discharge in view of the above-mentioned point.
[0006]
[Means for Solving the Problem] In order to solve the technical problem mentioned above, according to the exhaust emission control device of the internal combustion engine of this invention according to claim 1, it considered as the configuration which divides the discharge section and the dust collection section into the upstream and the downstream of the passage where exhaust gas flows, and arranges them. In the

configuration of this exhaust emission control device, while the plasma from the discharge section arranged to the upstream and gaseous pollutants, such as PM in exhaust gas and NOx, collide, passing the dust collection section arranged to the downstream, a probability of collision with a radical, activated gas, etc. which are further generated by the plasma is raised, and it is purified. PM which especially particulate matter (PM) reacted with the plasma in the discharge section since the conductor of the dust collection section was being fixed to predetermined potential, and was charged sticks to a conductor. Even if it was minute particulate matter (PM), after being caught by this, it reacts with the plasma generated in the discharge section, is changed into a carbon dioxide, and is removed from the dust collection section.
[0007] Moreover, like before, about the dust collection section, since it is not a **** configuration, an inter-electrode distance does not become large inter-electrode [of the discharge section]. That is, the exhaust emission control device of the internal combustion engine by which does not have the effect on the discharge section by the dust collection section being arranged, and discharge in the discharge section is stabilized can be offered.
[0008] According to claim 2 of this invention, by passing through the space of the shape of two or more clearance where exhaust gas was formed in the dust collection section, particulate matter (PM) is made to stick to the front face of the dust collection section, and is caught. And after making the plasma from this caught particulate matter (PM) and discharge section react and changing into a carbon dioxide, it removes from the dust collection section.
[0009] According to claim 2 of this invention, it is effective in reducing the pressure-loss resistance at the time of exhaust gas passing the dust collection section by constituting the dust collection section in a plane and arranging to the flow of exhaust gas, and parallel.
[0010] According to claim 3 of this invention, it is effective in making gaseous pollutants, such as nitrogen oxides (henceforth referred to as NOx), purify in the dust collection section by supporting the dust collection section with a catalyst.
[0011] According to claim 4 of this invention, it considered as the configuration which equips with the discharge section the upstream of the 1st and 2nd insulating substrate which carried out opposite arrangement across the passage where exhaust gas flows in addition to claim 1 and effectiveness according to claim 3, and equips the downstream with the dust collection section. That is, while being held between the 1st and 2nd insulating substrate which the conductor which constitutes a part of dust collection section counters, passage between the 1st and 2nd insulating substrate was used as the exhaust emission control device of a configuration of leading the radical generated by the plasma from the discharge section of the upstream, activated gas, etc. to the conductor side of the dust collection section. Thus, while the 1st and 2nd insulating substrate constitutes an exhaust gas path, since the function to hold the dust collection section by **** was given, the exhaust emission control device itself can be constituted in a compact.
[0012]
[Embodiment of the Invention] Hereafter, the exhaust emission control device of the internal combustion engine which is 1 operation gestalt of this invention is explained to a detail with reference to a drawing. In addition, as shown in drawing 1 , an exhaust emission control device 1 is constituted by the plasma generator 2 containing the discharge section 30 mentioned later and the dust collection section 70, and the high voltage power supply generating section 4 which impresses the alternating current high voltage of a RF to the electrode 3 of the discharge section 30 in this plasma generator 2. And as shown in drawing 7 , the plasma generator 2 is arranged in the middle of the exhaust pipe 51 of the engine 50 which is an internal combustion engine.
[0013] Next, the configuration of the plasma generator 2 is explained using drawing 3 from drawing 1 . Drawing 1 is the outline block diagram of the plasma generator 2 of 1 operation gestalt of this invention. Drawing 2 is the detail drawing showing the insulating substrate 5 in drawing 1 , and the top view (b) of (a) is a side elevation. Drawing 3 is an outline block diagram along the A-A line cross section of the plasma generator shown in drawing 1 .
[0014] The plasma generator 2 consists of the discharge section 30 and the dust collection section 70. In this equipment 2, two or more insulating substrates 5 are arranged in parallel at intervals of predetermined, and the flat passage 6 through which exhaust gas passes between each insulating substrate 5 is formed. Each insulating substrate 5 is formed with heat-resistant insulators (for example, ceramics, such as an

alumina, or glass etc.) with the dielectric which discharge tends to produce. In each insulating substrate 5, the electrode 3 for discharge formed with the printed conductor or the electric conduction plate, respectively is embedded.

[0015] The electrode 3 for these discharge is arranged at the upstream of the passage 6 where exhaust gas flows. That is, two or more electrodes 3 in each insulating substrate 5 which countered by **** are embedded in passage 6 only in each insulating substrate 5 of the upstream of the passage 6 where exhaust gas flows. And the electrode 3 and the high voltage power supply generating section 4 of these plurality are connected through connection terminal 3a, and the discharge section 30 which the alternating current high voltage of a RF is impressed [section] and generates the plasma is constituted.

[0016] Moreover, the dust collection section 70 is arranged at the downstream of the discharge section 30. That is, it considered as the configuration which divides the above-mentioned discharge section 30 and the dust collection section 70 into the upstream and the downstream of the passage 6 where exhaust gas flows, and arranges them. The conductor 7 which carries out the main configuration of this dust collection section 70 is being fixed to ground potential (touch-down) as predetermined potential with scissors rare ** by each insulating substrate 5 extended from the discharge section 30. And as a conductor 7 shows transverse-plane passage structure to drawing 4 , it is the structure of having the space of the shape of two or more clearance through which exhaust gas passes, and a transverse plane is a mesh-like using stainless steel in this example, and the appearance is formed in cube structure.

[0017] Thus, since the dust collection section 70 of a configuration of having mentioned above is not a **** configuration about the dust collection section 70 between the electrodes 3 of the discharge section 30, the distance L between electrodes 3 (it illustrates in drawing 3) does not become large. That is, if the distance between electrodes 3 becomes large, demand applied voltage (electrical potential difference which can generate discharge) will become high, discharge will become difficult, but since the dust collection section 70 divides and is arranged, a setup to arbitration is attained in the distance between electrodes 3. Therefore, the inter-electrode distance by which discharge in the discharge section is stabilized can be set up, and the plasma generator 2 by which discharge was stabilized can be constituted.

[0018] Moreover, since the conductor 7 is being fixed to ground potential while having the space of the shape of two or more clearance through which exhaust gas passes, the dust collection section 70 makes the particulate matter (PM) charged by discharge stick to the front face of a conductor 7, and promotes prehension.

[0019] PM shows the process in which the front face of the conductor 7 of the dust collection section 70 is adsorbed to drawing 5 . Drawing 5 is the explanatory view showing the principle of dust collection actuation of the dust collection section 70 of drawing 1 and the plasma generator 2 shown in 3. As shown in drawing 5 , PM is charged in response to the time of passing the discharge section 30 with the plasma, and will be in the potential level condition of plus or minus. And PM from which potential level changed to the potential level of plus or minus to the conductor 7 of a zero state by being fixed to ground potential adsorbs. And after PM caught with the conductor 7 making it react with a radical, activated gas, etc. from the discharge section 30 which are generated and changing it into a carbon dioxide, stopping at a conductor 7, it is removed from a conductor 7. In addition, the detail of the reaction from which PM is changed into a carbon dioxide is mentioned later.

[0020] Thus, by impressing the alternating current high voltage of a RF to the discharge section 30, and carrying out PM electrification, even if it is PM of a particle, it can catch in the dust collection section 70. The prehension effectiveness can catch from PM of a particle to large PM, as are shown in drawing 6 , and shown in the continuous line of (b) in drawing 6 by energizing in the discharge section 30 as compared with the case (broken line of (**) in drawing 6) where it does not energize in the discharge section 30.

[0021] The plasma generator 2 of a configuration of having mentioned above can lead a radical, activated gas, etc. which hold the distance between the insulating substrates 5 by which opposite arrangement was carried out by **** in the emission way 6 at convention spacing, and are generated from the discharge section 30 of the upstream through passage 6 to a conductor 7 in the dust collection section 70. Thus, while the insulating substrate 5 made to counter constitutes an exhaust gas path, since the function to hold the dust collection section 70 by **** was given, exhaust-emission-control-device 1 the very thing can be constituted in a compact.

[0022] An operation of the exhaust emission control device 1 constituted as mentioned above is explained below. An engine 50 starts and the high-pressure alternating voltage of a RF is impressed to two or more electrodes 3 which counter across each passage 6 from the high voltage power supply generator 4 in the discharge section 30 in the condition that the exhaust gas containing injurious ingredients, such as gaseous pollutants, such as NOx, and particulate matter (PM), is led to the plasma generator 2 through an exhaust pipe 51.

[0023] When the high-pressure alternating voltage of this RF is impressed to an electrode 3 and discharge occurs between electrodes 3, the oxygen molecule in exhaust gas and the acceleration electron e by discharge react, and O radical (O*) is generated. And this O radical (O*) and the nitrogen monoxide in exhaust gas (NO) join together, and a nitrogen dioxide (NO2) is generated.

[0024] Here, purification of the particulate matter in the exhaust gas which is an injurious ingredient (PM) is divided roughly into the soot (SOOT) which uses carbon (C) as a principal component, and the non-burned body (S. O.F.) which uses a hydrocarbon (HC) as a principal component. It reacts, as it is indicated in a degree type as this carbon (C) and a hydrocarbon (HC), and the nitrogen dioxide (NO2) generated by discharge. In the case of soot (SOOT), it is set to C+NO2 ->CO2+NO, and, in the case of the non-burned body (S. O.F.), reacts like HC+NO2 ->CO2+H2 O+NO. In addition, particulate matter (PM) and the nitrogen dioxide (NO2) generated by discharge react also under a low-temperature environment.

[0025] Next, in purification of the nitrogen oxides (NOx) of the gaseous contaminant in the exhaust gas which is an injurious ingredient, passing through the both sides of the dust collection section 70 which supported the discharge section 30 and a catalyst, as shown in a degree type, a reduction reaction is carried out, and a gaseous contaminant (NOx) and O radical (O*) generated by discharge serve as harmless gas (CO2, N2) and water, and is discharged.

[0026] Nitrogen oxides (NOx) are conjugated compounds of a nitrogen dioxide (NO2) and a nitrogen monoxide (NO), oxidize a nitrogen monoxide (NO) to a nitrogen dioxide (NO2) by discharge, and are promoting purification of exhaust gas. Moreover, the hydrocarbon (HC) which is a reducing agent is contained in exhaust gas as a non-burned component. Then, in the case of a nitrogen dioxide (NO2), it is set to NO2+HC->N2+CO2+H2O, and it is purified.

[0027] Thus, while stabilizing discharge in the discharge section 30 by having considered as the configuration which divides the discharge section 30 of an exhaust emission control device 1, and the dust-collection section 70 which supported the catalyst in the direction in which an emission way flows, and arranges it, the exhaust emission control device 1 of the internal combustion engine which the collision (contact) probability of the plasma and the exhaust-gas component which were generated in the discharge section 30 is raised, and can raise PM and the purification effectiveness of NOx can offer.

[0028] (Modification) Plasma generator 2A which is the modification of this invention is shown in drawing 8 . Drawing 8 is the outline block diagram showing the cross section of the plasma generator which is the modification of this invention. The same sign is substantially given to the same component part with the plasma generator 2 of 1 operation gestalt shown in drawing 3 from drawing 1 , and explanation is omitted. While plasma generator 2A shown in drawing 8 constitutes the conductor 17 of the dust collection section 70 from the electric conduction plate or conductive layer prolonged in the shape of a plate to the plasma generator 2 shown in drawing 3 from drawing 1 , the points which have arranged this conductor 17 to the flow of exhaust gas and parallel differ.

[0029] It is effective in reducing the pressure-loss resistance at the time of exhaust gas passing the dust collection section 70 by the configuration of this conductor 17.

[0030] In addition, although the insulating substrate 5 which carries out the interior of the discharge section 30 was made to extend in operation of this invention and **** constituted the conductors 7 and 17 of the discharge section 70 from this extended insulating substrate 5 What is necessary is just to lose the effect on the discharge section 30 by dividing the discharge section 30 and the dust collection section 70 into the upstream and the downstream of the passage 6 where exhaust gas flows, arranging them, and the dust collection section 70 being arranged, and the arrangement configuration of the insulating substrate 5 and the dust collection section conductors 7 and 17 which carry out the interior of the discharge section 30 may be carried out with another object. Moreover, the conductors 7 and 17 at the time of this another object configuration may be constituted in two or more layers, and it is unified and they may consist of simple

substances.

[0031] Moreover, the mesh front face of the conductor 7 made from stainless steel made [the shape of a mesh] to carry out a cube configuration may be made to support a catalyst in operation of this invention. This catalyst to support chooses the selection reduction catalyst which divides NOx into N2 and O2 by reducibility components in exhaust gas, such as HC, CO, and H2, the three-way catalyst which processes three injurious ingredients, HC, CO, and NOx, to coincidence, and which catalyst of an oxidation catalyst, or is used combining two or more catalysts. Thus, it is effective in making the cleaning effect of the nitrogen oxides (NOx etc.) of a gaseous contaminant promote by making the dust collection section 70 support a catalyst.

[0032] Furthermore, in operation of this invention, it may replace with the conductor 7 made from stainless steel, and conductor 7A shown in drawing 9 may be used. This conductor 7A consists of a porous body (it constitutes from ceramics, such as an alumina, or glass), is carrying out metal plating to this porous body front face, and constitutes the conductor with conductivity.

[0033] Furthermore, as shown in drawing 10 in operation of this invention, it is good also as a configuration of the exhaust emission control device 2 arranged combining the plasma generator 2 and catalyst equipment 52. Even when there is a gaseous contaminant which this catalyst equipment 52 is arranged on the exhaust gas lower stream of a river of the plasma generator 2, and passes the plasma generator 2, catalyst equipment 52 can purify this passed gaseous contaminant.

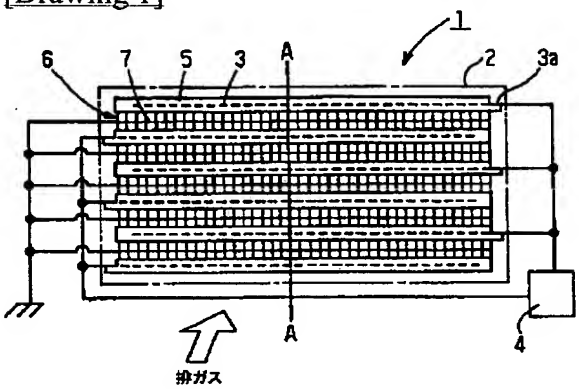
[Translation done.]

* NOTICES *

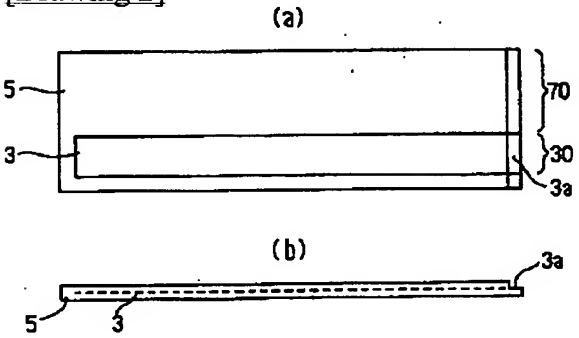
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

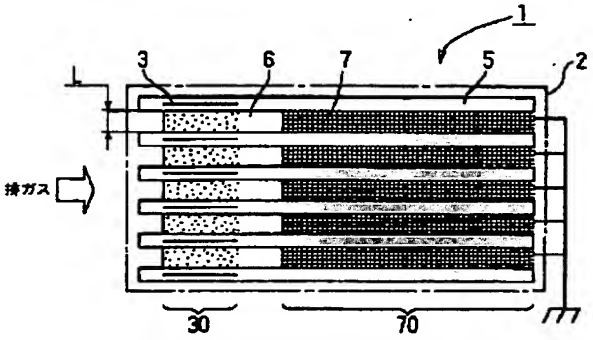
[Drawing 1]



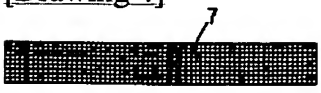
[Drawing 2]



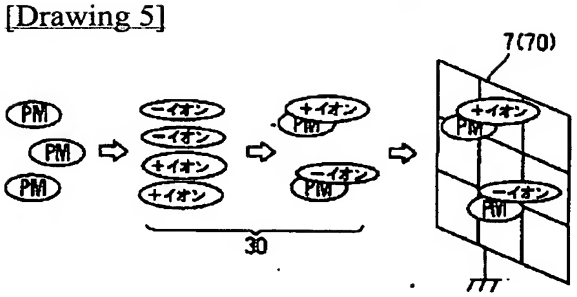
[Drawing 3]



[Drawing 4]

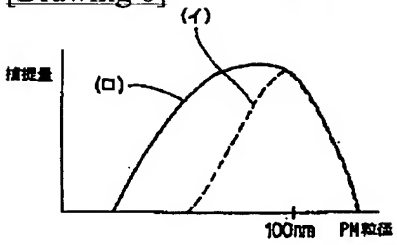


[Drawing 5]

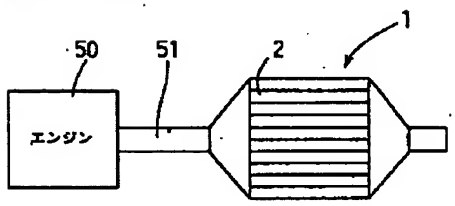


[Drawing 9]

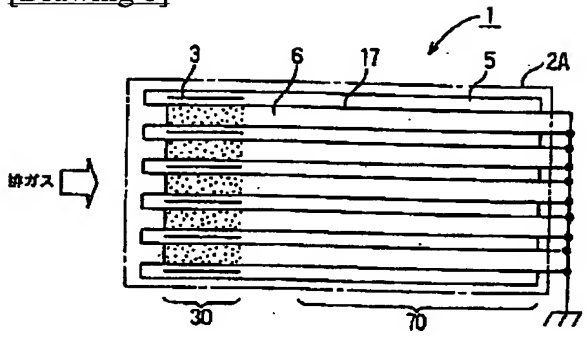
[Drawing 6]



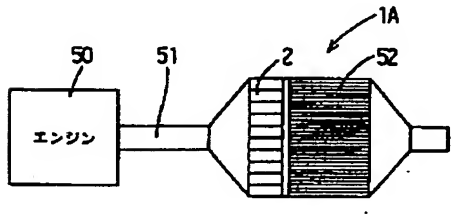
[Drawing 7]



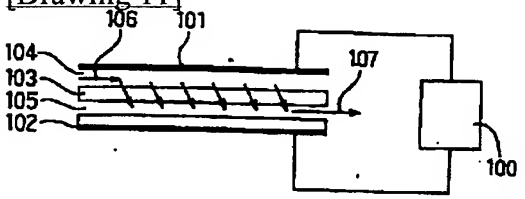
[Drawing 8]



[Drawing 10]



[Drawing 11]



[Translation done.]